# U.S. Vision for 2025 Air Transportation


**Doug Arbuckle**, *Agile Air Traffic System IPT Director*
**Col. David Rhodes**, *Shared Situation Awareness IPT Director*
**Mark Andrews**, *Weather IPT Director*
**Dennis Roberts**, *Airport Infrastructure IPT Director*
**Susan Hallowell**, *Security IPT Director*
**Dorenda Baker**, *Safety IPT Director*
**Carl Burleson**, *Environment IPT Director*
**Jack Howell**, *Global Harmonization IPT Director*
**Andy Anderegg**, *Chief Architect*
*Joint Planning and Development Office*


## INTRODUCTION

Today's U.S. air transportation system[1] is under stress. The demands on air transportation are outpacing our ability to increase system capacity. Operating and maintenance costs of the air traffic system are outpacing revenues and the air carrier industry is going through a period of dramatic change. Security requirements established in the wake of the 9-11 attacks significantly impact costs and the ability to efficiently move people and cargo. In addition, growth in air transportation is provoking community concerns over aircraft noise, pollution, and congestion. Adapting our current air transportation paradigm will not be sufficient to meet these challenges. Instead, transformation of today's system is required to ensure a healthy, environmentally friendly, globally interoperable air transportation system for 2025. Over the past two years, the Joint Planning and Development Office has developed strategies for developing the Next Generation Air Transportation System (NGATS). The NGATS vision for 2025 enables the safe, efficient and reliable movement of large numbers of people and goods throughout the air transportation system in a way that is consistent with national security objectives. Our NGATS vision is founded upon an underlying set of principles and enabled by a series of key capabilities that will free the U.S of many current system constraints, support a wider range of operations, and deliver an overall system capacity up to 3 times current operating levels.

## PRINCIPLES

NGATS is about the customers – the users of the air transportation system. It fosters a shift in the historical focus of air transportation from a system constrained by physical/technical infrastructure and the ability of the service providers, to a system focused on and responsive to the "user." The concept is multi-dimensional in scope—incorporating technological innovation, but also addressing the critical aspects of change and innovation in organization, culture, and policy. Safety in the NGATS is approached in a prognostic fashion, establishing a new safety culture that assesses risk in a predictive environment, instead of the existing reactive context. The system will enable integrated management of environmental performance to foster continued growth of aircraft operations in an expected future where the environmental impacts of aviation are increasingly scrutinized. International harmonization accommodates both the demands of U.S. users to operate globally without unnecessary constraint, and similarly, to embrace the needs of non-U.S. users to operate in the U.S. The above principles are discussed in more detail in "2005 Progress Report to the Next Generation Air Transportation System Integrated Plan" (2006).

## CAPABILITIES

We have defined several key capabilities that denote the major characteristics of the NGATS that are currently missing from today's system. As a "total system" concept, there are multiple dependencies among these capabilities. These key NGATS capabilities include: Network-Enabled Information Access; Performance-Based Services; Weather Assimilated into Decision Making; Broad-Area Precision Navigation; Aircraft Trajectory-Based Operations; Equivalent Visual Operations; and Super Density Operations.

### Network-Enabled Information Access

Making information available, securable and usable in real time according to defined "communities of interest" is central to the NGATS vision (see figure 1). Information will be used to distribute decision-making appropriately during normal operations, abnormal events, and system-wide crises -- improving the speed, efficiency, and quality of decisions. Aircraft will become mobile "nodes" integral to this information network,

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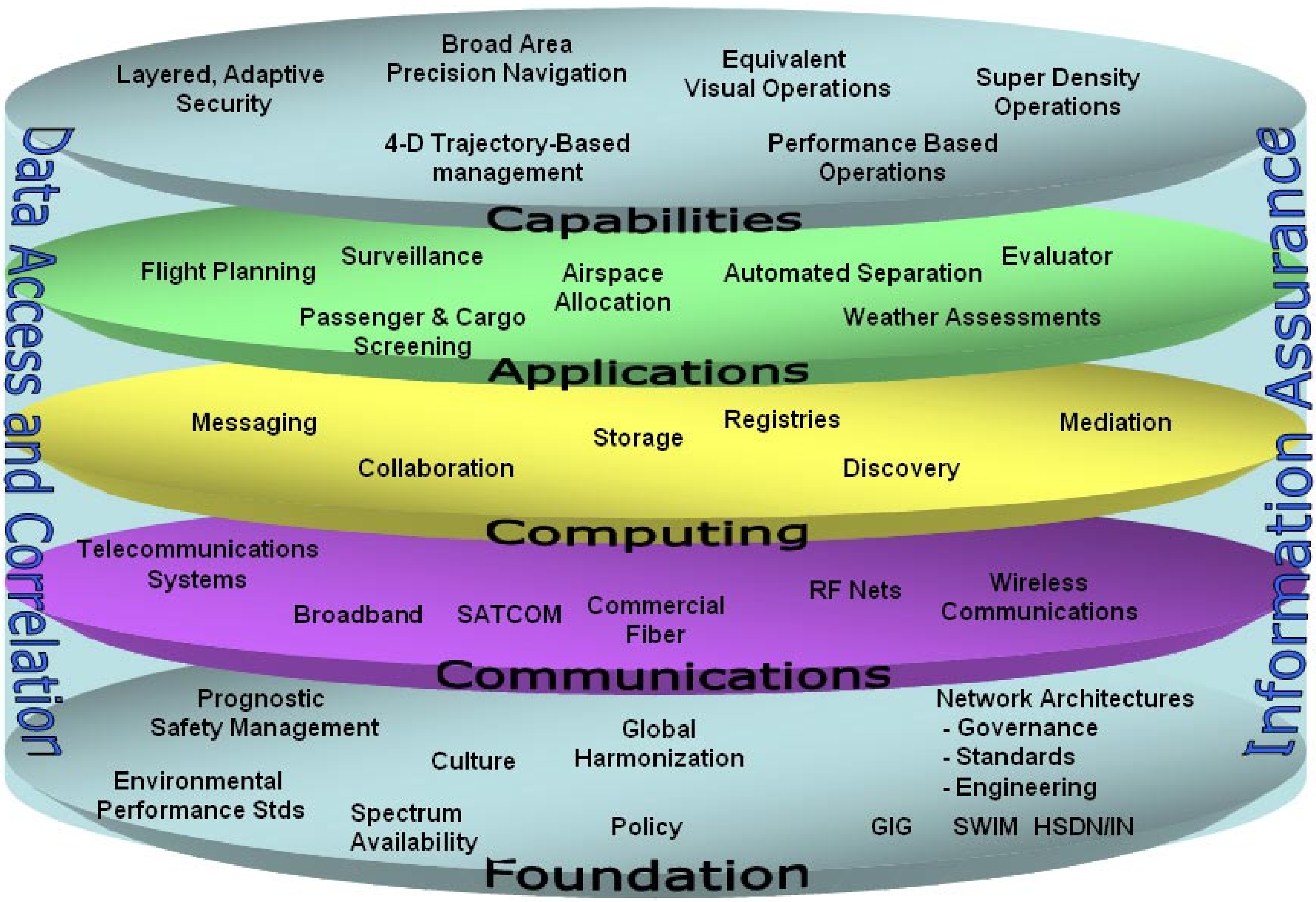


*Figure 1 – Network-Enabled Information Access: Information Sharing is Foundation to Capabilities*

not only using and providing information, but also routing messages or information being sent from another aircraft or a ground source. In the NGATS context, data encompasses all relevant information forms—flight plan information; pilot, passenger and cargo data; aircraft telemetry; surveillance information; weather data, etc. Information might be in the form of records, databases (pilots licenses, aircraft maintenance records, etc), voice communications, images, etc. Information will be both "pushed" to known users and available to be "pulled" by other users including clients not previously identified as needing that data. Data providers will ensure appropriate information protection as necessary to address national defense, security, and privacy concerns. Real-time access will enable system operators and users to exploit risk-management practices to enhance safety. The capability provides a "cooperative surveillance" model for civil aircraft operations, where aircraft will be constantly transmitting aircraft states (including position) and flight path intent. This information will be used together with a separate sensor-based non-cooperative surveillance system as part of an integrated federal surveillance approach for national security purposes.

## Performance-Based Services

Today's system is based on "binary access" (where users meet all of the requirements for access or are denied admission), one level of service (first come, first served), and a regulatory structure largely built around specific equipment types. Performance Based Services will enable a definition of service tiers and allow the government to move from equipment-based regulations to performance-based regulations. Multiple service levels will allow service to a wider range of users and better tailor services to individual needs. As an example, the busiest airspace will have the highest air traffic service level -- thus requiring the highest level of user avionics performance. Implementation of performance-based services will enable a more cost-effective service provider maintenance framework and will encourage private sector innovation. Clearly defined service tiers will allow the service provider to create service guarantees for given performance levels so that users can determine appropriate investments to meet their needs.

## Weather Assimilated Into Decision Making

Leveraging the benefits of *Network-Enabled Information Access*, NGATS will provide a "common" weather "picture" to support decision-making. Thousands of global weather observations - from ground, airborne, and space-based sources - will be used to determine real-time weather status and to feed multiple weather forecast models. Information will be fused into a single, constantly updated, national (eventually global) weather database. Differences between forecasts and actual conditions will be measured and analyzed. Analysis tools will examine how well information was used in past decision-making and use this knowledge to improve future performance, making more airspace available for NGATS use. NGATS will move from weather data dissemination of text and graphical products to ingestion of raw weather information into NGATS decision algorithms and processes - bypassing the need for human interpretation.

## Layered, Adaptive Security

Far from the "add-on" dimension of our current security system, layered, adaptive security will integrate security functions into NGATS in a manner that increases security while moving more people/goods and requiring proportionally fewer resources to do it. Building on *Network-Enabled Information Access* and *Performance-Based Services*, security will exist in "layers of defense" designed to detect threats early. Risk assessments will begin before each flight, so that people and goods are appropriately screened as they move from the "air portal" curb to the aircraft, or as they work to support airport and aircraft operations. As technology matures, screening will be unobtrusive and increasingly transparent to the individual. Security changes will be assessed in terms of impacts to and effects from other aspects of the system, such as safety, to ensure they are implemented in a complementary, synergistic way.

## Broad-Area Precision Navigation

Broad-Area Precision Navigation will provide navigation services where and when needed to enable reliable aircraft operations in nearly all conditions[2]. Today's U.S. navigation infrastructure includes over 5,000 FAA operated ground-based navigation aids to support both en-route navigation and precision approaches to airports. The airspace structure and approach/departure procedures are constrained by this navigation infrastructure. When this localized-service model is replaced by a broad-area service, "instrument" landings will be possible at any "air portal" or location within the coverage area. NGATS Broad-Area Precision Navigation (at different required levels of performance) will likely include a next generation of GPS satellites with non-terrestrial navigation augmentation for CAT-I approaches and hybrid GNSS/inertial avionics for CAT II/III approaches. NGATS may also take advantage of other GNSS systems and broad-area navigation services such as enhanced LORAN. Elimination of multiple legacy systems will reduce FAA infrastructure costs and reduce user costs associated with maintaining proficiency over multiple navigation systems.

## Aircraft Trajectory-Based Operations

To accommodate the projected doubling or tripling of system demand by 2025, today's flight planning and air traffic paradigms must be transformed to a system that manages operations based on aircraft trajectories, regularly adjusts the airspace structure to best meet user and security/defense needs, and relies on automation for trajectory analysis and separation assurance. This capability builds on the *Network-Enabled Information Access*, *Performance-Based Services*, *Weather Assimilated Into Decision Making,* and *Broad-Area Precision Navigation* capabilities. The design must not only improve system efficiency but also meet goals for security, safety and environmental compatibility. NGATS will use 4D trajectories (time-based paths from block-to-block, including ground segments) as the basis for planning and executing system operations. The planned trajectories will be exchanged among system participants, with automation continuously analyzing trajectories in a framework that accounts for operational uncertainties, to develop constantly updated trajectory plans that keep aircraft safely separated. The airspace structure will be matched dynamically (both daily and within the operational day) using a framework that seeks to allocate/configure airspace as a resource to meet demand from user operations, while meeting safety requirements, environmental requirements, etc. This airspace framework will consolidate today's disparate mechanisms for segregating and managing airspace into a single mechanism for implementing Temporary Flight Restrictions, Special Use Airspace, and other requirements. The airspace framework will seek to both provide the maximum available airspace to all users while meeting national security (DoD/DHS) needs for airspace restrictions.

One of the key concepts associated with this capability is the integration of trajectory planning/execution across the spectrum of time horizons from "strategic planning" to "separation management." To implement this integrated planning/execution function, we have conceived a notional concept to support the expected distributed decision-making environment that we have named the *"Evaluator."* The Evaluator will take 4D trajectory proposals from airspace system users (general aviation, passenger or cargo airlines, military, etc.) and assess these for mutual compatibility with airspace/system capacity. Users will be able to immediately "see" situations where "over demand" or contention for resources are projected to occur, and will be encouraged to play

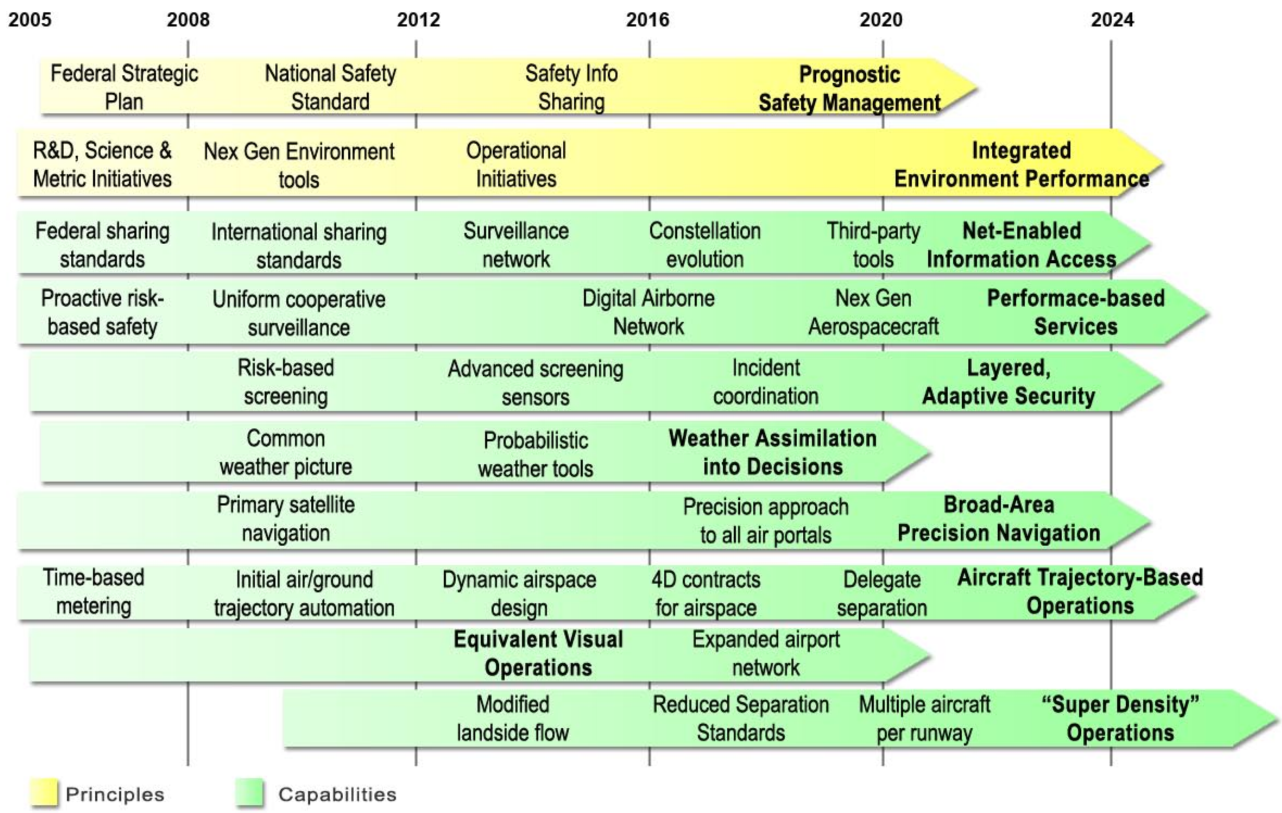


*Figure 2 – NGATS Top-level Roadmap*

an active role in the resolution process. The air traffic management system service provider will use the Evaluator to plan airspace configurations and allocate service provider resources to support changing user needs. Based on a set of published rules (jointly determined by the users and the service provider) the service provider will provide just-in-time "final arbitration" decisions when users are unable to resolve resource contentious situations. The Evaluator will provide a degree of transparency into the above decisions and actions for air traffic users, the air traffic service provider, airport operators, and other "communities of interest."

## Equivalent Visual Operations

*Network-Enabled Information Access*, certain aspects of *Performance-Based Services*, and *Broad-Area Precision Navigation* will provide aircraft with the critical information needed to navigate without visual references and maintain safe distances from other aircraft during non-visual conditions. We expect that the Equivalent Visual Operations capability will be operational in the mid-term, with controllers delegating responsibility to aircraft to "maintain separation" when the aircraft is in the airport area. The ability to conduct Equivalent Visual Operations at all "air portals," combined with appropriately capable landside services (including security) will permit more airports to reliably serve their community or region, whether for commercial service, business aviation, air taxi services, air cargo, or general aviation. The ability to conduct Equivalent Visual Operations at busier airports will also provide greater, more predictable operating levels (equivalent to those experienced under visual operations) and lead to improved performance of the commercial service network.

## Super Density Operations

Key to the complete success of NGATS is our ability to match land and airside throughputs of an airport in order to meet future demand. The realization of the previously described capabilities will enable peak throughput performance at the busiest airports while protecting the environment of the surrounding communities. Airport taxiway and runway configuration requirements will be specified to enable high capacity traffic operations on the airport surface. Arrival and departure spacing will be reduced, as a result of enhanced surveillance and navigation performance and the development and integration of tools to detect and avoid wake vortices. Capacity will be increased with closely-spaced and converging approaches at distances closer than currently allowed and through simultaneous operations on a single runway. The airport "landside" (including security systems) will be sized to match the passenger and cargo flow to the airside throughput.

## THE TRANSFORMATION STARTS NOW!

The strategy for NGATS is to define, as best we can, what the future system will look like, knowing full well that it is highly unlikely that the concept presented here will emerge exactly as the NGATS of 2025; rather, this vision of the future allows us to define a target direction and continue to develop the scope and depth of the elements of the future system. The Joint Planning and Development Office is building a roadmap (figure 2) that lays out the migration strategy from today to 2025 for each of the capabilities. Over time, as policy decisions are made and as we get research results to better understand the details of NGATS, the capability descriptions and the roadmap will be refined, policy decisions will be made, and detailed implementation plans will be developed and carried out.

**Doug Arbuckle**
A graduate engineer from Virginia Tech and George Washington University. He has worked for NASA since 1979, beginning as a researcher at Langley Research Center (LaRC), and serving in several LaRC management positions including Head of the Vehicle Operations Research Branch and Director of the Airborne Systems Competency.

He currently leads the JPDO Agile Air Traffic System IPT.

**Colonel Dave Rhodes**
Graduated first in his class at the US Air Force Academy and was Olmsted Scholar at the Universität Konstanz, Germany. He served as T-37 and F-15 instructor pilot; Air Liaison Officer during Operations DESERT SHIELD/STORM; Deputy Director of Operations in the NATO Combined Air Operations Center; Instructor in Political Science at the US Air Force Academy; National War College; and White House Fellow (Special Advisor for National Security Affairs to the Vice President). His command tours include F-15 Flight Commander and F-15 Squadron Commander, with several deployments to Southwest Asia.

He is Assistant for Information Integration, Office of the Assistant Secretary of Defense for Homeland Defense, and the lead for the JPDO Shared Situational Awareness IPT.

**Mark Andrews**
A graduate from the University of Michigan and Florida State University. He was a career officer in the US Air Force, retiring as a Lt Colonel in 2000 to join the National Weather Service, National Oceanic and Atmospheric Administration, US Department of Commerce. At the National Weather Service, he served as the aviation services chief and NOAA's Aviation Weather Program Manager prior to his selection to represent the Department of Commerce as the Weather IPT lead.

He currently leads the JPDO Weather IPT.

**Dennis Roberts**
A graduate of Central Missouri State University and a licensed instrument pilot.

He has a wide variety of aviation experience, having served as: Vice-President -Executive Director, Government and Technical Affairs for AOPA; Executive Director of the Division of Aeronautics for the State of Colorado; the Director of Regional Air Transportation Planning for the Denver Regional Council of Governments; senior aviation planner for Bucher, Willis and Ratliff/Coffman aviation consultants; and Deputy Executive Director for the Louisville Kentucky Regional Airport Authority.

He is Director of the Office of Airport Planning and Programming and leads the JPDO Airport IPT.

**Susan Hallowell**
A graduate chemist of Western Maryland College and University of Delaware.

She was a research chemist for the US Army in the area of detection of, and protection against, chemical warfare agents. She worked in the FAA and subsequently the Department of Homeland Security (DHS) in the area of explosives detection research and development, and is an expert in the area of trace detection of explosive.

From October 2004 until November 2005, Dr. Hallowell was the Director of the Transportation Security Laboratory, Transportation Security Administration, DHS, and led the JPDO Security IPT.

**Dorenda Baker**
A graduate engineer from California Polytechnic State University and a licensed instrument pilot. She began her career as an engineer with the Federal Aviation Administration Aircraft Certification Service in 1986. She served in various positions in the Small Airplane Directorate, the Transport Airplane Directorate and the Aircraft Certification Division in Brussels, Belgium.

From October 2004 until October 2005, she led the JPDO Safety IPT. She is currently the Deputy Director of the Aircraft Certification Service.

**Carl Burleson**
A graduate of the University of Virginia, American University, and Boston University.
He has held a number of positions within FAA, including Senior Representative for Northern Europe (US Embassy in London) and Chief of Staff to the FAA Administrator, as well a number of positions in policy, planning and regulatory analysis in Washington.

He is the Director of FAA's Office of Environment and Energy and leads the JPDO Environment IPT.

**Jack Howell**
A graduate engineer from University of Florida and MIT. He served as an F-4 pilot in the US Air Force and was a pilot for Eastern Airlines for 17 years before joining the FAA. In FAA, he served as Deputy Director of the William J. Hughes Technical Center and Manager, Flight Standards Technical Programs Division before going to the International Civil Aviation Organization (ICAO), where he served Director of the Air Navigation Bureau, Secretary to the ICAO Air Navigation Commission, and as the technical secretariat advisor to the ICAO Council.

He leads the JPDO Global Harmonization IPT.

**Andy Anderegg**
A graduate engineer from National Technological University and West Virginia Wesleyan College. As the Chief Architect for the Next Generation Air Transportation System, Mr. Anderegg led the development of the Integrated Plan for the Next Generation Air Transportation System. He is with the MITRE Corporation and has been on assignment to the Joint Planning and Development Office through an Intergovernmental Personnel Act agreement since 2003. In his 10 years with MITRE, he also led the development of the FAA' Operational Evolution Plan, and work on operational requirements and safety analysis methodologies for separation standards reductions and automated conflict detection tools in transoceanic air traffic management. His other experience includes eight years in development of joint service systems at a theater command level with Magnavox.

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[1] The current air transportation system is a complex array of systems and services used by an ever broadening collection of stakeholders. The term "the air transportation system" means all activities and components related to the safe passage of people and goods by air. This includes related federal lines of business, as well as private industry, state, and local activities.

[2] direct weather hazards to aircraft, such as severe thunderstorms, will effect operations at certain times.